

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. APPLN NO. 10/540,021

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (original): A method for carrying out a comprehensive quality control of a MOX fuel rod, comprising a combination of operations selected from the steps of:

measuring a plutonium content of pellets contained in said rod, and

checking for rogue pellets in said rod,

~~checking internal structure and constituents in said rod,~~

~~measuring dimensional characteristics of said rod~~

~~measuring radioactive contamination along a surface of said rod, and~~

~~checking conformity of a rod identity with plutonium enrichment;~~

characterized by: wherein:

~~moving the fuel rod is axially moved,~~

~~performing concurrently said measurements and checks are concurrently performed along the fuel rod moved axially, and~~

~~using radiometry, and/or radiography and/or electro-optical identification radiometry is used for said control, the plutonium content being measured and said rod simultaneously checked for rogue pellets through scanning of the native gamma radiation emitted by the plutonium and americium contained in the pellets with a single, or a plurality of, NaI and/or CdTe detector(s) with several different energy window discriminators.~~

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2. (original): The method, as claimed in claim 1, characterized by moving continuously said fuel rod at constant speed during said measurements and checks.

3. (currently amended): The method, as claimed in claim 1, characterized by simultaneously measuring the plutonium content and checking for rogue pellets through scanning of the native gamma radiation emitted by the plutonium and americium contained in the pellets with a single, or a plurality of, NaI and/or CdTe detector(s), in that said energy window discriminators comprise discriminators with at least the following energy windows:

below 100 KeV and above 500 KeV for detecting the native gamma radiation of ^{241}Am ;
and

between 90 KeV and 500 KeV for detecting the native gamma radiation of Pu and its decay products.

4. (previously presented): The method, as claimed in claim 1, characterized by simultaneously measuring the plutonium content and detecting rogue pellets through scanning of the gamma radiation emitted by the plutonium contained in the pellets after activation by thermalized neutrons from a ^{252}Cf or $^{241}\text{AmLi}$ source, the measuring being performed with a single, or a plurality of, NaI and/or CdTe detector(s).

5. (currently amended): The method, as claimed in claim 3, claim 1, characterized by simultaneously

detecting said gamma radiation with the plurality of detectors, the signals of which being discriminated with several energy windows,

temporally shifting the said delivered signals, and

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summing the shifted signals.

6. (previously presented): The method, as claimed in claim 1, characterized by simultaneously

checking the internal structure through subjecting the rod to an external ^{241}Am or ^{137}Cs gamma source, and

scanning the traversing gamma radiation with a single gamma detector.

7. (currently amended): The method, as claimed in claim 1, characterized by simultaneously measuring an external alpha contamination through a single annular alpha detector without contacting the fuel rod.

8. (previously presented): The method, as claimed in claim 1, characterized by simultaneously checking conformity of a rod identity with the plutonium content through electro optical reading or image processing of identification code(s).

9. (currently amended): The method as claimed in claim 1, characterized in that moving the fuel rod is carried out by using two independent but strictly synchronized driving mechanisms, one located at a feed end and one at an exit end of a rod scanning apparatus designed for said method, comprising said detector(s) so as to insure ensure a constant progression of the fuel rod through the apparatus from one end plug of the fuel rod to another, said two mechanisms being spaced at a distance shorter than the length of the rod.

10 (currently amended): An apparatus for carrying out said comprehensive MOX fuel rod quality control method according to claim 1, characterized by: comprising:

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means for moving the fuel rod axially at constant speed, comprising at least two independent but strictly synchronized driving mechanisms, one located at feed end and one at an exit end of the rod control apparatus,

a series of measuring and checking systems aligned along the path of travel of said fuel rod and operating concurrently, and

~~said systems being selected from a group comprising radiometry, radiography and electro optical identification systems.~~ a radiometry system having a single or a plurality of NaI and/or CdTe detectors with several different energy window discriminators for measuring the plutonium content and detecting rogue pellets by scanning the native gamma radiation emitted by the plutonium and americium contained in the pellets.

11. (currently amended): The apparatus according to claim 10 characterized by a single or a plurality of NaI and/or CdTe detectors for measuring the plutonium content and detecting rogue pellets by scanning the native gamma radiation emitted by the plutonium and americium contained in the pellets. in that said energy window discriminators comprise at least one energy window discriminator for each of the following energy windows:

below 100 KeV and above 500 KeV for detecting the native gamma radiation of ^{241}Am ;
and

between 90 KeV and 500 KeV for detecting the native gamma radiation of Pu and its decay products

12. (currently amended): The apparatus according to claim 10 characterized in that, for measuring the plutonium content and detecting rogue pellets, said apparatus further comprises :

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a ^{252}Cf or $^{241}\text{AmLi}$ source of thermalized neutrons for activation of the plutonium, and a single or a plurality of NaI and/or CdTe detectors for the scanning of the gamma radiation emitted by the activated plutonium contained in the pellets.

13. (currently amended): The apparatus according to claim ~~44-10~~ characterized by a single or a plurality of annular detectors for measuring the plutonium content and detecting rogue pellets.

14. (currently amended): The apparatus according to claim ~~44-10,~~ characterized by a ~~plurality of energy discriminators and means for summing temporally shifted γ - counts.~~

15. (currently amended): The apparatus according to claim 10 characterized in that, for checking the internal structure and constituents of the rod, said apparatus further comprises :

an external ^{241}Am or ^{137}Cs source of gamma radiation, and
a single gamma detector for scanning of the gamma radiation traversing the fuel rod.

16. (currently amended): The apparatus according to claim 10 characterized in that, for measuring radioactive contamination of cladding along the rod, said apparatus comprises :

a single or a plurality of annular alpha detectors for scanning of the alpha radiation emitted by an external surface of the fuel rod.

17. - 18. (canceled).

19. (new): The method according to claim 4, wherein said energy window discriminators also comprise discriminators with at least one of the following energy windows:

between 150 KeV and 350 KeV for detecting the native gamma radiation of ^{237}U
resulting from the radioactive decay of ^{241}Pu ; and/or

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between 350 KeV and 500 KeV for detecting the native gamma radiation of ^{239}Pu .

20. (new): The apparatus according to claim 11, wherein said energy window discriminators also comprise discriminators with at least one of the following energy windows:

between 150 KeV and 350 KeV for detecting the native gamma radiation of ^{237}U resulting from the radioactive decay of ^{241}Pu ; and/or

between 350 KeV and 500 KeV for detecting the native gamma radiation of ^{239}Pu .